The outcome of total hip replacement in obese and non-obese patients at 10- to 18-years

J. R. McLaughlin, K. R. Lee

From the Kennedy Center for the Hip and Knee, Oshkosh, USA

We studied a consecutive series of 285 uncemented total hip replacements in 260 patients using the Taperloc femoral component and the T-Tap acetabular component. The outcome of every hip was determined in both living and deceased patients. A complete clinical and radiological follow-up was obtained for 209 hips in 188 living patients, followed for a mean of 14.5 years (10 to 18.9). They were divided into two groups, obese and non-obese, as determined by their body mass index. There were 100 total hip replacements in 89 patients in the obese cohort (body mass index \( \geq 30 \text{ kg/m}^2 \)), and 109 in 99 non-obese (body mass index < 30 kg/m\(^2\)) patients. A subgroup analysis of 31 patients of normal weight (body mass index 20 kg/m\(^2\) to 25 kg/m\(^2\)) (33 hips) and 26 morbidly obese patients (body mass index \( \geq 35 \text{ kg/m}^2 \)) (30 hips) was also carried out.

In the obese group five femoral components (5%) were revised and one (1%) was loose by radiological criteria. Femoral cortical osteolysis was seen in eight hips (8%). The acetabular component was revised in 57 hips (57%) and a further 17 (17%) were loose. The mean Harris hip score improved from 52 (30 to 66) pre-operatively to 89 (49 to 100) at final follow-up. Peri-operative complications occurred in seven patients (7%).

In the non-obese group six (6%) femoral components were revised and one (1%) was loose. Femoral cortical osteolysis occurred in six hips (6%). The acetabular component was revised in 72 hips (66%) and a further 18 (17%) were loose. The mean Harris hip score increased from 53 (25 to 73) prior to surgery to 89 (53 to 100) at the time of each patient’s final follow-up radiograph.

No statistically significant difference was identified between the obese and non-obese patients with regards to clinical and radiological outcome or complications. The subgroup analysis of patients of normal weight and those who were morbidly obese showed no statistically significant difference in the rate of revision of either component.

Our findings suggest there is no evidence to support withholding total hip replacement from obese patients with arthritic hips on the grounds that their outcome will be less satisfactory than those who are not obese.

The incidence of obesity in Western society has dramatically increased over the past decade. In 1994 the National Institute of Health reported that 33% of American citizens were overweight and 16% were obese.\(^1\) In 2004, 66% of Americans were classified as overweight and 31% as obese.\(^2\) There is, however, little data available on the long-term results of total hip replacement (THR) in obese patients, partly due to the reticence of surgeons to perform this procedure on patients who are overweight. Charnley\(^3\) cited obesity as a contraindication to THR and several authors have expressed concerns about an increased risk of infection, thromboembolic disease and early mechanical failure.\(^4-10\) In addition, because of the increased stress placed on prosthetic components in obese patients, there is a perceived risk of an increased rate of polyethylene wear and peri-prosthetic osteolysis.\(^4,5,11,12\) Several series describing the long-term results of cemented THR in obese patients have demonstrated an increased incidence of loosening of the components using both first generation and modern techniques of cementing.\(^6,12-15\) In these reports, however, obese patients made up only a small subset of the patients.\(^6,12-15\) There are few accounts of the results of uncemented THR in obese patients;\(^10,16,17\) short-term studies have found no difference in the incidence of loosening or peri-operative complications when compared with patients who were not obese.\(^10,16,17\)

The purpose of our retrospective study was to compare the long-term results of un-
cemented THR in obese patients as regards durability of fixation, prevalence of osteolysis and the incidence of complications. These results were compared with those obtained in non-obese patients by the same surgeon, using the same prosthetic components with the same length of follow-up. The T-tap acetabular component (Biomet Inc., Warsaw, Indiana) used in this series functioned poorly. The Taperloc femoral component (Biomet Inc.) is associated with excellent fixation and a low incidence of osteolysis.18

**Patients and Methods**

**Patients.** We studied 285 consecutive uncemented primary THRs in 260 patients carried out between September 1983 and June 1987. No patient was lost to follow-up, although 72 (76 hips) died prior to obtaining the minimum ten-year follow-up. In one of these patients a well-fixed femoral component had been removed during acetabular revision and a further seven acetabular components had been revised. The remaining 188 patients (209 hips) were divided into two groups, obese and non-obese, as determined by their body mass index (BMI).

The BMI of the patients was calculated as the body weight in kilograms, divided by the height in metres squared. Obesity was defined as a BMI of 30 kg/m² or greater in accordance with the National Institute of Health guidelines.1

The obese group, with a BMI of 30 kg/m² or greater, consisted of 89 patients (100 hips). Among these, five hips had undergone revision of both the femoral and acetabular component. In the remaining 95 hips in 84 patients, complete clinical and radiological follow-up was obtained (Table I). There were 35 women (37 hips) and 49 men (58 hips), with a mean follow-up of 14.6 years (10 to 18.7). The mean age of the patients at the time of operation was 54 years (20 to 77) and the mean BMI was 34 kg/m² (30 to 51). The pre-operative diagnosis in this group was osteoarthritis in 65 hips (68.4%), rheumatoid arthritis in 13 (13.7%), developmental dysplasia of the hip in nine (9.4%), avascular necrosis in seven (7.4%), and a fracture of the hip in one (1.1%).

There were 99 non-obese patients (109 hips) with a BMI of less than 30 kg/m². Of these, six hips had undergone revision of both components. In the remaining 103 hips in 93 patients, complete clinical and radiological follow-up was obtained. The mean age of the patients at the time of surgery was 57 years (20 to 82) and the mean BMI was 26 kg/m² (20 to 29). There were 55 women (63 hips) and 38 men (40 hips), who were followed up for a mean of 14.3 years (10 to 18.9). The pre-operative diagnosis in this group was osteoarthritis in 63 hips (61%), rheumatoid arthritis in 14 (14%), developmental dysplasia in 12 (12%), avascular necrosis in 11 (10%), and a fracture of the hip in three (3%).

A subgroup analysis of patients of normal weight (BMI 20 kg/m² to < 25 kg/m²) and morbidly obese patients (BMI ≥ 35 kg/m²) was also carried out. There were 31 patients of normal weight (33 hips) and 26 morbidly obese patients (30 hips).

**Procedure.** The Taperloc femoral component was used in all patients. It is collarless and made of wrought titanium alloy (Ti-6Al-4V; Biomet Inc.) with a wedge shape, designed to achieve fixation mediolaterally within the proximal femur. The proximal 40% of the implant is textured with a titanium alloy (Ti-6Al-4V) coating applied by plasma spray. All the femoral components had a 28 mm head (Fig. 1). The acetabular component used was the T-tap. This is a conically-shaped, threaded ring titanium shell with a 28 mm articulating surface (Biomet Inc.).

The procedures for this study were approved by the Institutional Review Board and written informed consent was obtained from all patients. One surgeon (who was not an author of this study), using a posterolateral approach to the hip, performed all the operations. No special instruments or surgical techniques were used for the obese patient. An intra-operative radiograph was obtained on every hip to

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**Table I. Comparison of demographic data**

<table>
<thead>
<tr>
<th></th>
<th>Obese group (n = 95)</th>
<th>Non-obese group (n = 103)</th>
</tr>
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<tbody>
<tr>
<td>Mean BMI ² in kg/m² (range)</td>
<td>34 (30 to 51)</td>
<td>26 (20 to 29)</td>
</tr>
<tr>
<td>Mean age in yrs (range)</td>
<td>54 (20 to 77)</td>
<td>57 (20 to 82)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>49 (58 hips)</td>
<td>38 (40 hips)</td>
</tr>
<tr>
<td>Female</td>
<td>35 (37 hips)</td>
<td>55 (63 hips)</td>
</tr>
<tr>
<td>Mean duration of follow-up in yrs (range)</td>
<td>14.6 (10 to 18.7)</td>
<td>14.3 (10 to 18.9)</td>
</tr>
<tr>
<td>Mean Harris hip score (range)</td>
<td>89 (49 to 100)</td>
<td>89 (53 to 100)</td>
</tr>
<tr>
<td>Thigh pain</td>
<td>4 hips</td>
<td>3 hips</td>
</tr>
<tr>
<td>Osteolysis</td>
<td>8 hips</td>
<td>6 hips</td>
</tr>
<tr>
<td>Peri-operative complications</td>
<td>7 hips</td>
<td>5 hips</td>
</tr>
<tr>
<td>Mean operative blood loss in ml (range)</td>
<td>670 (400 to 1900)</td>
<td>650 (400 to 1800)</td>
</tr>
<tr>
<td>Mean transfusion PRBC ² in units (range)</td>
<td>2.2 (1 to 5)</td>
<td>2.1 (1 to 6)</td>
</tr>
<tr>
<td>Mean operative time in mins (range)</td>
<td>110 (65 to 175)</td>
<td>107 (70 to 160)</td>
</tr>
<tr>
<td>Mean length of hospital stay in days (range)</td>
<td>11 (8 to 21)</td>
<td>12 (6 to 32)</td>
</tr>
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</table>

² BMI, body mass index
* PRBC, packed red blood cells
assess the position of the components. Antibiotics were administered pre-operatively and continued for 48 hours after operation. Patients were allowed to partially weight-bear for six weeks and thereafter advanced to full weight-bearing.

**Evaluation.** Radiological evaluation at a mean of 14.5 years (10 to 18.9) consisted of anteroposterior (AP) views of the hip and pelvis and a true lateral view of the hip. These were compared with the immediate post-operative radiographs and all subsequent follow-up films. All the radiographs were examined by an independent orthopaedic surgeon (JRM) who was not the operating surgeon and to eliminate bias, each was read without the knowledge of the BMI of the patient. The femur was divided into the seven zones described by Gruen, McNeice and Amstutz, and all the radiographs were assessed for radiolucencies in each of these zones and recorded in increments of half a millimetre. Progressive radiolucencies were identified and recorded. Radiolucencies containing a scalloped or cystic appearance, or greater than 2 mm in width, were recorded as osteolysis. Ostelysis was characterised by the criteria of Goetz, Smith and Harris as mild, intermediate or extensive.

The stability of the femoral component was evaluated using the criteria of Engh, Bobyn and Glassman. Subsidence was determined by a comparison of two measurements between serial radiographs as described by Pellegrini, Hughes and Evarts. A difference greater than 4 mm was required for this determination. Acetabular fixation was assessed by the criteria of Massin, Schmidt and Engh, and the acetabular component was considered loose if there was migration from either the inter-teardrop or vertical line, a continuous radiolucency, or a change ≥ 4° in the angle of abduction.

The patients were evaluated clinically by one author (JRM), who was not the operating surgeon at a clinical examination, or by a telephone interview and questionnaire. The Harris hip score was used to determine the level of function and to evaluate pain. In addition, the presence or absence of thigh pain was recorded. The activity level was evaluated by the classification of Johnston et al (Table II). At final follow-up, in the obese group 70 patients with 81 hips (85%) were examined clinically and 14 patients with 14 hips (15%) were assessed by a questionnaire and a telephone interview, while in the non-obese group 69 patients with 77 hips (75%) were examined clinically and 24 patients with 26 hips (25%) were assessed by a questionnaire and a telephone interview.

**Statistical analysis.** The Kaplan-Meier survivorship analysis was used to estimate a cumulative survival function for the femoral and acetabular components, with revision as the end-point. Log-rank analysis was used to determine the statistical significance of the relationship between the variables. The Fisher exact test was also performed when indicated. A p-value ≤ 0.05 was considered to be significant.

**Results**

**Obese patient group.** Of the 100 THRs in 89 patients, five femoral components in five patients required revision, none

<table>
<thead>
<tr>
<th>Classification</th>
<th>Obese group (number of hips = 95)</th>
<th>Non-obese group (number of hips = 103)</th>
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</thead>
<tbody>
<tr>
<td>Heavy manual labour (%)</td>
<td>12 (12)</td>
<td>10 (10)</td>
</tr>
<tr>
<td>Moderate manual labour (%)</td>
<td>28 (29)</td>
<td>21 (20)</td>
</tr>
<tr>
<td>Light labour (%)</td>
<td>32 (34)</td>
<td>48 (47)</td>
</tr>
<tr>
<td>Semi-sedentary (%)</td>
<td>23 (24)</td>
<td>16 (15)</td>
</tr>
<tr>
<td>Sedentary (%)</td>
<td>0 (0)</td>
<td>8 (8)</td>
</tr>
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</table>

**Table II. Level of activity**
for aseptic loosening. One was revised for sepsis and the remaining four were revised at the time of acetabular revision. Of the femoral components which had not undergone revision, 90 (95%) were determined to have fixation by bone ingrowth, four (4%) showed stable fibrous ingrowth and one (1%) was unstable at a mean follow-up of 14.6 years (10 to 18.7). The acetabular component required revision in 57 hips (57%), one for infection and the remainder for aseptic loosening. Of the 43 acetabular components still in place (43%) at a mean of 14.6 years (10 to 18.7), 17 (17%) were loose by radiological criteria.

Kaplan-Meier survivorship analysis with revision as the end-point estimated a 94% chance of survival for the femoral component at 18 years (95% confidence interval (CI) 0.91 to 0.99) (Fig. 2a) and a 39% chance of survival for the acetabular component (95% CI 0.28 to 0.49) (Fig. 2b). There was no statistically significant difference between patients requiring revision and gender (p = 0.16) in this group.

At final follow-up the mean Harris hip score had improved from 52 (30 to 66) pre-operatively to 89 (49 to 100). Thigh pain was present in four hips (4%). The clinical outcome of 54 hips (57%) was graded as excellent, 28 (29%) as good, nine (10%) as fair, and four (4%) as poor, with a Harris hip score below 70.

Radiographs were obtained on all 95 THRs which had not undergone revision. Radiolucencies in the porous-coated region of the femoral component was present in six hips (6%), most commonly in Gruen zone 1 on the AP radiograph at final follow-up. The immediate post-operative radiographs showed that 69 hips (73%) had a neutral stem position, 17 (18%) were in valgus, and nine (9%) were in varus. Femoral cortical osteolysis was present in eight hips (8%). Major osteolysis occurred in only two hips (2%). In the eight THRs in which femoral osteolysis was seen, six were in men and two were in women. No statistically significant relationship was found between osteolysis and activity (p = 0.65), initial alignment of the femoral component (p = 0.29), or gender (p = 0.99).

There were peri-operative complications in seven patients (seven hips) (Table III). The mean operative time was 110 minutes (63 to 175) with a mean blood loss of 670 ml (400 to 1900). No transfusion was required in 62 hips, five needed one unit of packed red blood cells, 20 two units, six three units, one four units and one five units. In the patients requiring transfusion, the mean amount transfused was 2.2 units (1 to 5). The mean length of hospital stay was 11 days (8 to 21).

Non-obese patient group. Of the 109 THRs in 99 patients, six had revision of the femoral component, one for loosening secondary to an intra-operative fracture of the proximal femur, two for late sepsis at two and ten years respectively, and three well-fixed femoral components were revised at the time of acetabular revision. Of those which were not revised 99 (96%) were determined to have fixation by bone ingrowth, three (3%) showed stable fibrous ingrowth while one (1%) was unstable. The acetabular component in 70 hips (64%) was revised for aseptic loosening, two (2%) required revision for late sepsis and 37 (34%) remained in place, of which 18 (49%) were radiologically loose.

Kaplan-Meier survivorship analysis with revision as the end-point estimated a 95% chance of survival for the femoral component at 18 years (95% CI 0.91 to 0.99) (Fig. 3a),
and a 26% chance of survival for the acetabular component (95% CI 0.17 to 0.37) (Fig. 3b). There was no statistically significant difference between patients requiring revision surgery, and gender (p = 0.68) in this group.

The mean Harris hip score increased from 53 (25 to 73) pre-operatively to 89 (53 to 100) at final follow-up. Thigh pain was present in three hips (3%). The clinical outcome of 51 hips (49%) was graded as excellent, 41 (40%) as good, seven (7%) as fair, and four (4%) as poor according to the Harris hip score.

Radiographs were obtained on all 103 THRs which had not undergone revision. Radiolucencies in the porous-coated region of the femoral component were seen in 10 hips (10%), most commonly in Gruen zone 1 on the AP radiograph at final follow-up. The immediate post-operative radiographs showed that 54 hips (52%) had a neutral stem position, 37 (36%) were in valgus, and 12 (12%) were in varus. Femoral cortical osteolysis was present in six hips (6%). Major osteolysis occurred in only one hip (1%). In the six THRs in which femoral osteolysis occurred, three were in men and three were in women. No statistically significant correlation between osteolysis and activity (p = 0.86), initial alignment of the femoral component (p = 0.76) or gender (p = 0.68) was found.

There were peri-operative complications in five patients (five hips) (Table III). The mean operative time was 107 minutes (70 to 160), with a mean blood loss of 650 ml (400 to 1800). No transfusion was required in 26 hips, six need one unit of packed red blood cells, 60 required two units, ten required three and one had six. In those patients requiring transfusions, the mean amount transfused was 2.1 units (1 to 6) packed red blood cells. The mean length of hospital stay was 12 days (6 to 32). No statistically significant difference between these parameters was found in obese or non-obese patients.

**Subgroup analysis.** Subgroup analysis of the 33 hips in patients of normal weight showed that two femoral components (6%) were revised (one for sepsis and one well-fixed component during acetabular revision) as well as 23 acetabular components (70%) (one for sepsis and 22 for aseptic loosening). In the 30 hips of morbidly obese patients, one femoral component (3%) was revised for sepsis and 14 acetabular components (47%) were revised for loosening (Table IV).

Statistical analysis demonstrated no significant difference between the obese and non-obese group of patients with regard to revision of the femoral (p = 0.82) or the acetabular component (p = 0.30), osteolysis (p = 0.58) or complications (p = 0.45). No significant difference was found between these two groups in loosening of the femoral (p = 0.99) or acetabular component (p = 0.92). No significant difference was found between all patients requiring revision and gender (p = 0.54). The subgroup analysis also showed no significant difference between morbidly obese patients and patients of normal weight with regards to revision of the femoral (p = 0.37) or acetabular component (p = 0.78).

**Discussion**

The consensus report from the National Institute of Health recommends considering the use of uncemented THR in high-risk patients such as the young, active and obese. The results of cemented THR in obese patients have been

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**Fig. 3a** Kaplan-Meier curves for the non-obese group using revision as the end-point, showing the rate of survival of a) the femoral component and b) the acetabular component.

**Table IV.** Body mass index (BMI) as related to component revision (subgroup analysis of all 209 hips)

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Femoral revision (number of hips)</th>
<th>Acetabular revision (number of hips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 to 25 (%)</td>
<td>2/33 (6%)</td>
<td>23/33 (70%)</td>
</tr>
<tr>
<td>25 to 30 (%)</td>
<td>4/76 (5%)</td>
<td>49/76 (64%)</td>
</tr>
<tr>
<td>30 to 35 (%)</td>
<td>4/70 (6%)</td>
<td>43/70 (67%)</td>
</tr>
<tr>
<td>≥ 35 (%)</td>
<td>1/30 (3%)</td>
<td>14/30 (47%)</td>
</tr>
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</table>
discouraging. Surin and Sundholm\textsuperscript{14} noted an increased incidence of aseptic loosening following THR using first generation cementing techniques in obese patients. Chandler et al\textsuperscript{6} found an increased incidence of loosening of the femoral and acetabular components in young patients undergoing a cemented THR with a weight in excess of 82 kg. Sporer et al,\textsuperscript{12} evaluating the results of third-generation cementing techniques in patients less than 50 years of age, reported a statistically significant increase in aseptic loosening and revision of the femoral component as the weight of the patients increased. Our review of the literature revealed very few reports on uncemented THR in obese patients. Lehman et al\textsuperscript{16} observed no increase in aseptic loosening or revision of the femoral component in obese and morbidly obese patients following uncemented THR at a follow-up of four years. To our knowledge, no long-term results on the reports of uncemented THR in obese patients have been published.

Total hip replacement in obese patients is perceived by many authors\textsuperscript{3,5-9} to be associated with a higher rate of complications. The results regarding the incidence of perioperative complications in this series of obese and non-obese patients are similar to those reported for patients undergoing primary THR in the general population.\textsuperscript{8,10,12,29} The incidence of deep-vein thrombosis in patients undergoing THR prophylactically treated with warfarin, has ranged from 14% to 26%.\textsuperscript{29-35} The incidence of non-fatal pulmonary embolism has ranged from 1% to 2%, with fatal pulmonary emboli occurring in approximately one per 1000 patients.\textsuperscript{29-35} In this series, two obese patients (2%) and one non-obese patient (1%) developed deep-vein thrombosis. One obese patient (1%) developed a non-fatal pulmonary embolism.

Post-operative dislocation of a primary THR has been reported in between 0.5% and 3% of patients.\textsuperscript{7,8,17,18,36-38} We had no post-operative dislocations in the obese group. One non-obese patient (1%) developed recurrent dislocation requiring acetabular revision. No patient required readmission for a post-operative wound infection or wound dehiscence. The incidence of complications in both obese and non-obese patients in our study are compatible with the lower to normal range described in the literature.\textsuperscript{8-10,12,29}

In our 10- to 18-year clinical and radiological comparison of uncemented THRs in obese and non-obese patients, we could not find any statistically significant difference between the groups with regards to any aspect of outcome. A subgroup analysis of morbidly obese patients and patients of normal weight also showed no statistically significant differences in the rate of femoral or acetabular revision.

The most striking finding in this series was the equivalent results achieved in obese and non-obese patients undergoing primary uncemented THR. These results do not show any reason to withhold THR from patients with arthritic hips on the basis of obesity.

**References**


**Supplementary Material**

A further opinion by Mr Alistair Ross is available with the electronic version of this article on our website at www.jbjs.org.uk.

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